SECTION 1 INTRODUCTION

The Port of Long Beach (the Port or POLB) shares San Pedro Bay with the neighboring Port of Los Angeles (POLA). Together, the two ports comprise a significant regional and national economic engine for California and the United States (U.S.), through which approximately 32% of all containerized trade⁴ in the nation flows (14% for POLB alone). Combined, the POLB and POLA’s customs district account for approximately $300 billion in annual trade. Despite a recent worldwide downturn in shipping, economic forecasts suggest that the demand for containerized cargo moving through the San Pedro Bay region will increase significantly over the next two decades. The economic benefits of the ports are felt throughout the nation.

The ports recognize that their ability to accommodate the projected growth in trade will depend upon their ability to address adverse environmental impacts (and, in particular, air quality impacts) that result from such trade. Therefore, in November 2006, the two ports adopted their landmark, joint Clean Air Action Plan (CAAP) designed to reduce health risks while allowing port development to continue. This detailed annual activity-based inventory, with associated emissions estimates, is a critical and integral component to the success of the CAAP.

The Port is a landlord port; it builds terminal facilities and leases them to shipping lines and stevedoring companies. The Port does not operate the terminals, ships, yard equipment, trucks or trains that move the cargo.

1.1 Reason for Study

The Port released its first activity-based emissions inventory in April 2004. The 2002 Baseline Air Emissions Inventory⁵ evaluated emissions from three Port-related source categories: off-road cargo handling equipment, rail locomotives and on-road heavy-duty vehicles that operates within the Port’s boundary. An Addendum to the 2002 Inventory⁶ was concurrently developed with the 2005 Inventory⁷ to evaluate emissions from ocean-going vessels, harbor craft, and the off-Port emissions associated with rail locomotives and on-road heavy-duty vehicles. As a follow-up to the 2005 inventory, the 2006 Air Emissions Inventory⁸ was released in June 2008 and included emission estimates for greenhouse gases (GHGs) for Port-related maritime mobile sources for the first time.

⁴ 2009 Container Traffic North America (1990-2009), see www.aapa-ports.org/industry/
⁵ Port of Long Beach, 2002 Baseline Emissions Inventory: Cargo Handling Equipment, Rail Locomotives & Heavy-Duty Vehicles, prepared by Starcrest Consulting Group, April, 2004.
Subsequently, the 2007 and 2008 Inventory of Air Emissions were released in January and December 2009, respectively.  

1.2 Goods Movement

Goods Movement (GM) has become a key issue associated with both the growth of the California economy and the significant challenges to meeting the National Ambient Air Quality Standards (NAAQS) in the South Coast Air Basin (SoCAB). The Business, Transportation and Housing Agency (BTH) and the California Environmental Protection Agency (Cal/EPA) have jointly adopted a Goods Movement Action Plan (GMP). The GMP is intended to develop an action plan to address GM related issues such as current and future infrastructure needs, impact on environment, adverse impact mitigation measures to protect public health and community concerns, public safety and security issues, and workforce development opportunities regarding goods movement. As stated in the GMP, “...it is the policy of this Administration to improve and expand California’s goods movement industry and infrastructure in a manner which will:

- Generate jobs
- Increase mobility and relieve traffic congestion
- Improve air quality and protect public health
- Enhance public and port safety
- Improve California’s quality of life"

The GMP is focused to address goods movement in California’s four major “port-to-border” goods movement corridors:

- Los Angeles-Long Beach/Inland Empire
- Bay Area
- San Diego/Border
- Central Valley

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Over decades, these corridors have become major routes for ship to rail, ship to truck, and truck to rail exchanges to move millions of containers per year to their ultimate destinations. As stated in the GMP, “to help develop order of magnitude estimates of how effort should be distributed among the corridors, the agencies compiled a series of indices to compare and contrast key indicators among the corridors. Items included:

- Value by customs district
- Maritime container volume
- Port of entry tonnage
- Logistics jobs
- Daily vehicle hours of delay
- Mean average annual daily truck volume
- Total emissions per day
- Population

While the relative fractions or contributions of each of these factors vary by corridor, an un-weighted aggregate of the fractions indicate that the Los Angeles/Long Beach-Inland Empire corridor in southern California ranks first by a large margin with about 60 percent of the aggregate shares. The Bay Area, Central Valley, and San Diego corridors represent 19 percent, 13 percent, and 8 percent, respectively. More specific analysis will be necessary to determine the relative allocation of effort among the corridors to achieve simultaneous and continuous improvement.”

As a part of the GMP, the California Air Resources Board (CARB) is responsible for developing an emissions reduction plan based on international as well as domestic goods movement related future activities of the four corridors mentioned above. In April of 2006, CARB adopted the *Emissions Reduction Plan for Ports and Goods Movement in California*. The international goods movement category includes emissions from all on-port sources, including:

- All ocean-going vessels up to 24 nautical miles
- All harbor craft up to 24 nautical miles
- All cargo handling equipment
- All on-port trucks operation
- All on-port rail operations
- International goods movement portion of off-port truck operation
- International goods movement portion of off-port rail operation

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According to the GMP, the State’s five specific goals for addressing the air pollution associated with goods movement are:

1. Reduce total statewide international and domestic goods movement emissions to the greatest extent possible and at least back to 2002 levels by year 2010;

2. Reduce the statewide diesel particulate matter (PM) health risk from international and domestic goods movement 85 percent by year 2020;

3. Reduce oxides of nitrogen (NOx) emissions from international goods movement in the South Coast 30 percent from projected year 2015 levels, and 50 percent from projected year 2020 levels based on preliminary targets for attaining federal air quality standards;

4. Apply the emission reduction strategies for ports and goods movement statewide to aid all regions in attaining air quality standards; and

5. Make every feasible effort to reduce localized risk in communities adjacent to goods movement facilities as expeditiously as possible.”

In 2007, CARB adopted the State Strategy for California’s 2007 State Implementation Plan which included a number of specific control strategies targeting goods movement. These strategies have either been adopted into regulations or are currently under development.

1.3 Container Movements

Container terminals and their associated cargo movements are complex intermodal operations that are critical to international trade. Containerized cargo has significantly increased the efficiency and capacity the transportation system over the prior general cargo/break bulk cargo models (which still exist for non-containerized cargo). Due to the inherent efficiencies of containerized cargo, the types of cargo shipped via containers are increasing annually. To better understand the operations of the international transportation network associated with ports, this subsection describes overseas container transport, import cargo containers export cargo containers, and how empty cargo containers are handled.

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13 CARB 2006.
Oversea Container Transport
Imported cargo generally starts at an overseas manufacturer, supplier, or consolidation facility, where items are boxed and placed inside metal shipping containers. Containers generally come in two common lengths: 20 feet or one twenty-foot equivalent (TEU), and 40 feet or two TEUs. Other sizes such as 45 feet and 53 feet are also used. The U.S. buyer may contact an industry professional known as a “freight forwarder,” or logistics company, to coordinate landside transportation of the cargo. The container is then transported to a foreign port, assessed for possible security risks, and placed on board a containership, which is specifically designed to carry containerized cargo. Containerships calling at the Port range from 2,000 to over 8,000 TEUs per ship. The containership transports the containerized cargo to the Port, where it is unloaded, and forwarded to local or national destinations. Figure 1.1 presents the steps that are associated with overseas cargo movements.

15 Port of Long Beach, Cargo Movement In Focus, 2006.
Figure 1.1: Overseas Container Transport

Key:
1) Product ordered
2) Container transported to foreign port (not shown)
3) Security check conducted by U.S. Customs agents based at foreign ports
4) Container loaded onboard
5) Coast Guard review conducted for ship, crew, and cargo manifests
6) Containership boarded and docked by a Port pilot
7) Ship unloaded by longshore workers (see Figure 1.2 for details)
8) Security check conducted by U.S. Customs agents
9) Container surveyed for radiation
Import Container Transport
Once the ship arrives at the Port, the imported containers are either transported by train or by truck to their final destination, or to one of several intermediate destinations such as a railyard, warehouse, distribution center, or “transload” facility (a sorting, routing, and short-term storage facility). A container’s final destination will determine exactly what path it will take once it leaves the dock. Figure 1.2 illustrates the steps that are associated with imported container cargo movements16.

16 Port of Long Beach, Cargo Movement In Focus, 2006.
Key:

1) Containership unloaded; the marine terminal operator will arrange for unionized longshore workers to unload the ship. Containers are place on trucks, rail, or terminal cargo handling equipment for storage on terminal.

2) Trucking company or train operator contacted by freight forwarder or logistics provider to move container out of the terminal.

3) Cargo placed directly on rail using “on-dock” rail (as available).

4) Near-dock rail yards are used for terminals without on-dock rail or if additional rail capacity is needed. Trucks are used to “dray” containers from terminals to railyard.

5) Off-dock railyards are used to coordinate rail deliveries to national destinations. Containers are delivered by truck, then sorted and grouped by final destination. These railyards handle Port cargo as well as domestic cargo from other sources.

6) Containers are often moved initially to a “transload” facility where cargo is unloaded, sorted, and repackaged into larger-sized truck trailers. The cargo is then delivered from the facility to regional distribution centers, local stores, or off-dock railyards.
Export Container Transport
Export container cargo is similar to import containers however the flow is in the opposite direction. As with imported cargo, exported cargo may require multiple intermediate stops between its producer/manufacturer and the Port. Figure 1.3 presents the steps that are associated with exported container cargo movements.17

17 Port of Long Beach, Cargo Movement In Focus, 2006.
Key:

1) Local origin cargo delivered directly to the marine terminal from the producer, manufacturer, or exporting company.
2) Local or non-local origin cargo delivered to a warehouse/consolidator where the cargo may be temporarily stored with other cargo bound for export. Cargo may also be transferred from domestic truck trailers to marine shipping containers.
3) Some non-local origin cargo shipped by rail and delivered to off-dock railyards where the cargo is placed onto truck for final delivery to marine terminals.
4) Some non-local origin cargo shipped by rail directly to the marine terminal where it is loaded onto a ship or stored temporarily for the appropriate ship to arrive.
5) Some non-local origin cargo shipped by rail to near-dock railyards, where the cargo is picked up by truck for a short trip to the marine terminal.
6) Vessel loading of export cargo conducted after the ship has been unloaded of its import cargo.
Empty Containers
Since the U.S. imports more goods than it exports, many empty containers are sent overseas to be reused or are used domestically for other purposes. Typically, about a third of the containers loaded onto a ship at the Port will be filled with cargo, while about two-thirds will be empty. The figure below, diagrams the movement of empty containers after the delivery of full, imported containers to local businesses and/or transload facilities\(^\text{18}\). Intermodal containers returning to the local area empty are not depicted; they would enter the system at the marine terminal or empty container storage yard.

\(^{18}\) Port of Long Beach, Cargo Movement In Focus, 2006.
Key:
1) Empty container delivered to a local exporter to fill. Direct delivery of containers between importers and exporters is encouraged to reduce the number of truck trips a container takes in the South Coast.
2) Empty container delivered to container storage yard from a transload facility or local importer. From the storage yard, containers are moved by truck to the marine terminal for export or to a local exporter to be filled with cargo.
3) Empty container delivered directly from a transload facility or local importer to the marine terminal for export.
4) Empty container loaded onto a containership to be exported and reused overseas.
1.4 Regulatory and San Pedro Bay Ports Clean Air Action Plan (CAAP) Measures

This section discusses the regulatory and Port measures which address port-related activity. Almost all port-related emissions are attributable to five diesel-fueled source categories: ocean-going vessels (OGVs), on-road heavy-duty vehicles (HDVs), cargo handling equipment (CHE), harbor craft and rail locomotives (RL). The responsibility for the emissions control of the majority of these sources falls under the jurisdiction of local (South Coast Air Quality Management District, SCAQMD), state (CARB) or federal (U.S. Environmental Protection Agency, EPA) agencies. The ports of Long Beach and Los Angeles adopted the landmark Clean Air Action Plan (CAAP) in November 2006 to curb port-related air pollution from trucks, ships, locomotives and other equipment by at least 45 percent in five years. A model for seaports around the world, the CAAP is the boldest air quality initiative by any seaport, consisting of wide-reaching measures to significantly reduce air emissions and health risks while allowing for the development of much-needed port efficiency projects. Below is a list of recently adopted and proposed regulatory measures in addition to the CAAP measures that will reduce emissions from the ports over the next five years and beyond.

1.4.1 Ocean-Going Vessels

Emissions Standard for Marine Propulsion Engines

The International Maritime Organization (IMO) adopted limits for NOx in Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL) in 1997. These NOx limits apply to marine engines over 130 kilowatts (kW) installed on vessels built on or after 2000. The current NOx standards are from 17.0 grams per kilowatt hour (g/kW-hr) (for < 130 rpm) to 9.8 g/kW-hr (for ≥ 2000 rpm), depending upon the engine speed in rpm. The required number of countries ratified the Annex in May 2004 and it went into force for those countries in May of 2005. Engine manufacturers have been certifying engines to the Annex VI NOx limits since 2000 as the standards are retroactive in other countries, once Annex VI was ratified. In April 2008, the Marine Environment Protection Committee of the IMO approved a recommendation for new MARPOL Annex VI sulfur limits for fuel and NOx limits for engines. In October 2008, the IMO adopted these amendments to international requirements under MARPOL Annex VI, which place a global limit on marine fuel sulfur content of 3.5% by 2012, reduced from the current 4.5%, which will be further reduced to 0.5% sulfur by 2020, or 2025 at the latest, pending a technical review in 201819. In Emissions Control Areas (ECAs), sulfur content will be limited to 1.0% in 2010, and further reduced to 0.1% sulfur in 2015 from the current 1.5% limit. In addition, new engine emission rate limits for NOx for marine diesel engines installed on newly built ships are based on rated engine speed (n) and the year the ship is built.

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The NOx standards are summarized as follow:

NOx - Tier I; for ships built between January 1, 2000 and December 31, 2010:

- 17.0 g/kW-hr if n is less than 130 rpm
- 45 x n \(^{(0.2)}\) g/kW-hr if n is equal to or greater than 130 rpm and less than 2,000 rpm
- 9.8 g/kW-hr if n is equal to or greater than 2,000 rpm

NOx - Tier II; for ships built starting in January 1, 2011:

- 14.4 g/kW-hr if n is less than 130 rpm
- 44 x n \(^{(0.23)}\) g/kW-hr if n is equal to or greater than 130 rpm and less than 2,000 rpm
- 7.7 g/kW-hr if n is equal to or greater than 2,000 rpm

NOx - Tier III; for ships built starting in January 1, 2016 and operate in ECA area:

- 3.4 g/kW-hr if n is less than 130 rpm
- 9 x n \(^{(0.2)}\) g/kW-hr if n is equal to or greater than 130 rpm and less than 2,000 rpm
- 2.0 g/kW-hr if n is equal to or greater than 2,000 rpm
- Tier III NOx standards are based on the use of advanced catalytic after treatment systems.

Finally, existing ships built between 1990 and 2000, would be subject to a retrofit requirements of Tier I NOx standard. On July 21, 2008, President Bush signed into law the Maritime Pollution Protection Act of 2008, ratifying MARPOL Annex VI by the United States, and the requirements became enforceable through the Act to Prevent Pollution from Ships (APPS) in January 2009.

In March 2009, the United States and Canada submitted a proposal to the IMO for the designation of an ECA in which the stringent international emission controls described above would apply to ocean-going ships in waters adjacent to the Pacific coast, Atlantic/Gulf coast, and the eight main Hawaiian Islands. On March 26, 2010, the IMO officially designated waters within 200 miles of North American coasts as an ECA. From the effective date in 2012 until 2015, fuel used by all vessels operating in this area cannot exceed 1.0 percent sulfur (10,000 part per million [ppm]) which will be further reduced to 0.1 percent (1,000 ppm) beginning in 2015. Also, starting in 2016, NOx after-treatment requirements (Tier III standards) will become applicable in this area.
EPA's Final Regulation – Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters Per Cylinder

On March 14, 2008\textsuperscript{20}, the EPA finalized a three part program designed to dramatically reduce emissions from marine diesel engines below 30 liters per cylinder displacement. These include marine propulsion engines used on vessels and marine auxiliary engines. When fully implemented, this rule will cut PM emissions from these engines by as much as 90 percent and NO\textsubscript{x} emissions by as much as 80 percent.

The regulations introduced two tiers of standards – Tier 3 and Tier 4 – which apply to both new and remanufactured marine diesel engines, as follows:

- **Newly-built engines:** Tier 3 standards apply to engines used in commercial, recreational and auxiliary power applications (including those below 37 kW that were previously covered by non-road engine standards). The emissions standards for newly-built engines will phase in beginning in 2009. Tier 4 standards apply to engines above 600 kW (800 hp) on commercial vessels based on the application of high-efficiency catalytic after-treatment technology, phasing in beginning in 2014.

- **Remanufactured engines:** The standards apply to commercial marine diesel engines above 600 kW when these engines are remanufactured and will take effect as soon as certified systems are available, as early as 2008.

**EPA's Emission Standards for Marine Diesel Engines Above 30 Liters per Cylinder (Category 3 Engines)**

EPA is pursuing two parallel, related actions for establishing emission standards for Category 3 marine diesel engines: (1) EPA is a member of the United States delegation that participated in negotiations at the International Maritime Organization (IMO) with regard to amendments to Annex VI that were adopted in October 2008 including additional NO\textsubscript{x} limits for new engines, additional sulfur content limits for marine fuel, methods to reduce PM emissions, NO\textsubscript{x} and PM limits for existing engines, and volatile organic compounds (VOCs) limits for tankers; (2) In January 2003, EPA adopted Tier 1 standards for Category 3 marine engines, which went into effect in 2004, establishing NO\textsubscript{x} standards based upon internationally negotiated emissions rates and readily available emissions-control technology. In December 2009, EPA finalized emission standards for Category 3 marine diesel engines installed on U.S. flagged vessels as well as marine fuel sulfur limits which are equivalent to the amendments recently adapted to MARPOL Annex VI. The final regulation would establish stricter standards for NO\textsubscript{x}, in addition to standards for HC and CO.

\textsuperscript{20} See: \url{http://www.epa.gov/otaq/regs/nonroad/420f08004.htm#wchauxt}
The final near-term Tier 2 NO\textsubscript{x} standards for newly built engines will apply beginning in 2011 and will require more efficient use of current engine technologies, including engine timing, engine cooling, and advanced computer controls. The Tier 2 standards will result in a 15\% to 25\% NO\textsubscript{x} reduction below the current Tier 1 levels. The final long-term Tier 3 standards for newly built engines will apply beginning in 2016 in Emission Control Areas and will require the use of high efficiency emission control technology such as selective catalytic reduction to achieve NO\textsubscript{x} reductions 80\% below the current levels. These standards are part of EPA’s coordinated strategy for addressing emissions from ocean-going vessels which also includes implementation of recent amendments to MARPOL Annex VI and designation of U.S. coasts as an Emission Control Area.

**CAAP Measure- SPBP-OGV\textsubscript{2}; Reduction of At-Berth OGV Emissions**

This measure requires the use of shore-power for reducing hotelling emissions implemented at all major container and cruise terminals at the Port as soon as possible. Through the Technology Advancement Program, this measure also requires demonstration and application of alternative emissions reduction technologies for ships not capable of shore power.

**CAAP Measure- SPBP-OGV\textsubscript{5}; OGV Main &Auxiliary Engine Emissions Improvements**

This measure provides for main and auxiliary engine emissions reductions that are validated through the Technology Advancement Program. The goal of this measure is to reduce main and auxiliary engine DPM, NO\textsubscript{x}, and SO\textsubscript{x} emissions by 90\%. The first engine emissions reduction technology identified for this measure is the use of MAN B&W slide valves for main engines. The implementation mechanism for this measure is the terminal lease renewal.

**CARB’s Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-going Vessels While at Berth at a California Port\textsuperscript{21}**

On December 6, 2007, CARB adopted a regulation to reduce emissions from diesel auxiliary engines on OGV while at-berth for container, cruise and refrigerated cargo vessels. The regulation requires that auxiliary diesel engines on OGV to be shut down (i.e., use shore-power) for specified percentages of fleet’s visits and also the fleet’s at-berth auxiliary engine power generation to be reduced by the same percentages. As an alternative, vessel operators may employ any combination of clean emissions control technologies to achieve equivalent reductions. Specifically, by 2014, vessel operators relying on shore power are required to shut down their auxiliary engines at-berth for 50 percent of the fleet’s vessel visits and also reduce their onboard auxiliary engine power generation by 50 percent. The specified percentages will increase to 70 percent in 2017 and 80 percent in 2020.

For vessel operators choosing the emission reduction equivalency alternative, the regulation requires a 10% reduction in OGV hotelling emissions starting in 2010 increasing in stringency to an 80% reduction by 2020.

**CAAP Measure- SPBP-OGV1; Vessel Speed Reduction (VSR) Program**

In May 2001, a Memorandum of Understanding (MOU) between the Port of Long Beach, the Port of Los Angeles, EPA Region 9, CARB, SCAQMD, the Pacific Merchant Shipping Association (PMSA), and the Marine Exchange of Southern California was signed. This MOU called for OGVs to voluntarily reduce speed to 12 knots at a distance of 20 nautical miles (nm) from Point Fermin. The term of this MOU expired in 2004; however, a significant number of the OGVs operating at the Port have continued to abide by VSR speeds within 20 nm from Point Fermin. The CAAP measure requires 90% VSR compliance for OGVs that call on the Port. Reduction in speed demands less power on the main engine, which in turn reduces NOx emissions and fuel usage.

**Port of Long Beach Green Flag Program**

The Port has committed as much as $2.2 million a year to encourage participation in the Voluntary Vessel Ship Speed Reduction Program. Vessels that dock at the Port of Long Beach earn a Green Flag Environmental Achievement Award when they attain 100% compliance with the voluntary vessel speed reduction program for a 12-month period. Carriers that achieve a 90% compliance rate in a 12-month period are eligible for a 15% reduction in dockage otherwise payable to the Port (Green Rate) in the following year.

In 2008, the Board of Harbor Commissioners approved an expansion of the VSR compliance zone to 40 nm from Point Fermin starting in January 2009. Vessel operators that achieve a 90% compliance rate to 40 nm of Point Fermin within a 12-month period would receive an incentive rate that is 25% less than regular dockage otherwise payable to the Port (Green Plus Rate) in the following calendar year. In 2009, the VSR compliance rate was 95% within the 20 nm of the Port and 72% within the 40 nm zone.

**CARB’s Low Sulfur Fuel for Marine Auxiliary Engines, Main Engines and Auxiliary Boilers**

On July 24, 2008, CARB adopted low sulfur fuel requirements for marine main engines, auxiliary engines and auxiliary boilers within 24 nm of the California coastline. The regulation requires the use of marine gas oil (MGO) with a sulfur content less than 1.5% by weight or marine diesel oil (MDO) with a sulfur content of equal to, or less than 0.5% by weight. For auxiliary engines, main engines and boilers, the requirements started on July 1, 2009. The use of MGO or MDO with a sulfur content of equal to or less than 0.1% will be required in all engines and boilers by January 1, 2012. The use of low sulfur fuel will reduce emissions of NOx, DPM and SOx.
**CAAP Measures - SPBP-OGV3 and 4; OGV Main & Auxiliary Engine Fuel Standards**
This measure is designed to require the use of lower sulfur distillate fuels in the auxiliary and main engines of OGVs within 20 nm (later extending to 40 nm) of Point Fermin and while at berth. Upon lease renewal, this measure requires the use of distillate fuels that have a sulfur content of ≤0.2% MGO. The ports are focusing these measures to target fuel quality with the goal of synchronizing both the auxiliary and main engine fuels.

**Low-Sulfur Vessel Fuel Incentive Program**
In order to accelerate the emissions reductions from OGVs, the ports of Long Beach and Los Angeles adopted an incentive program in March 2008 to encourage vessel operators to discontinue the use of highly polluting bunker fuel in favor of cleaner, ≤0.2 percent low sulfur distillate fuel. The program paid eligible shipping lines the difference between the cost of bunker fuel and the more expensive low-sulfur distillate when used in main engines provided that the vessels used low-sulfur distillate fuel in their auxiliary engines while at berth and complied with SPBP-OGV1 (the Vessel Speed Reduction program). This program encouraged and accelerated the use of cleaner fuels in ocean-going vessels prior to the implementation of lease-based low-sulfur fuel agreements and prior to the start of international treaties, and EPA or CARB regulation requiring low sulfur fuel use. This program started July 1, 2008 and ended June 30, 2009, upon the implementation of statewide low sulfur fuel regulation.

**CARB’s Regulation Related to Ocean-going Vessel Onboard Incineration**
This regulation was adopted by CARB’s board in 2005 and was amended in 2006. As of November 2007, it prohibits all cruise ships and ocean-going vessels of 300 registered gross tons or more from conducting on-board incineration within 3 nm of California coast. Enactment of this regulation will reduce toxics air contaminants such as dioxins and toxics metals exposure to public. It will also reduce PM and hydrocarbon emissions generated during incineration.

**1.4.2 Harbor Craft**

**EPA’s Emission Standards for Harbor Craft Engines**
On March 14, 2008, EPA finalized the latest regulation establishing new emission standards for new “Category 1 & 2” diesel engines rated over 50 horsepower (hp) used for propulsion in most harbor craft. The new Tier 3 engine standards phase in starting in 2009. The more stringent Tier 4 engine standards (based on the application of high-efficiency catalytic after-treatment technologies) would phase in beginning in 2014 and apply only to commercial marine diesel engines greater than 800 hp. The regulation also includes requirements for remanufacturing commercial marine diesel engines greater than 800 hp.
CARB's Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft\textsuperscript{22}

As a part of the Diesel Risk Reduction Plan and Goods Movement Plan, CARB adopted a regulation in November 2007 that will reduce DPM and NO\textsubscript{x} emissions from new and in-use commercial harbor craft operating in Regulated California Waters (i.e., internal waters, ports, and coastal waters within 24 nm of California coastline). Under CARB's definition, commercial harbor craft include tug boats, tow boats, ferries, excursion vessels, work boats, crew boats, and fishing vessels. This regulation requires stringent emission limits from auxiliary and propulsion engines installed in commercial harbor craft. All in-use, newly purchased, or replacement engines must meet EPA’s most stringent emission standards per a compliance schedule set by the CARB for in-use engines and from new engines at the time of purchase. In addition, the propulsion engines on all new ferries, with the capacity of more than 75 passengers, acquired after January 1, 2009, will be required to install control technology that represents the best available control technology in addition to an engine that meets the Tier 2 or Tier 3 EPA marine engine standards, as applicable, in effect at the time of vessel acquisition. For harbor craft with home ports in the SCAQMD, the compliance schedule is accelerated by two years (compared to statewide requirements) in order to achieve earlier emission benefits required in SCAQMD. The in-use emission limits only apply to ferries, excursion vessels, tug boats and tow boats. The compliance schedule for in-use engine replacement begins in 2009.

CARB’s Low Sulfur Fuel Requirement for Harbor Craft

In 2004, CARB adopted a low sulfur fuel requirement for harbor craft. Starting January 1, 2006 (in SoCAB) harbor craft are required to use on-road diesel fuel (e.g., ultra-low sulfur diesel [ULSD]), which has a sulfur content limit of 15 ppm and a lower aromatic hydrocarbon content. The use of lower sulfur and aromatic fuel has resulted in NO\textsubscript{x} and DPM reductions. In addition, the use of low sulfur fuel will facilitate retrofitting harbor craft with emissions control devices such as diesel particulate filters (DPFs) that have the potential to reduce PM by additional 85%.

\textsuperscript{22} See: http://www.arb.ca.gov/regact/2007/eb07/isor.pdf.
1.4.3 Cargo Handling Equipment

Emissions Standards for Non-road Diesel Powered Equipment

The EPA’s and CARB’s Tier 1, Tier 2, Tier 3, and Tier 4 (interim Tier 4 and final) emissions standards for non-road diesel engines require compliance with progressively more stringent standards for hydrocarbon, CO, DPM, and NOx. Tier 4 standards for non-road diesel powered equipment complement the 2007+ on-road heavy-duty engine standards which require 90 percent reductions in DPM and NOx compared to current levels. In order to meet these standards, engine manufacturers will produce new engines with advanced emissions control technologies similar to those already in place for on-road heavy-duty diesel vehicles. These standards for new engines will be phased in starting with smaller engines in 2008 until all but the very largest diesel engines meet NOx and PM standards in 2015. Currently, the interim Tier 4 standards include a 90% reduction in PM and a 60% reduction in NOx.

CARB’s Cargo Handling Equipment Regulation

In December 2005, CARB adopted a regulation designed to reduce emissions from CHE such as yard tractors and forklifts starting in 2007. The regulation calls for the replacement or retrofit of existing engines with engines that use Best Available Control Technology (BACT). Beginning January 1, 2007 the regulation requires newly purchased, leased, or rented yard tractors to be equipped with a 2007 or later on-road engine or a Final Tier 4 off-road engine. Newly purchased, leased or rented non-yard tractors must be equipped with a certified on-road or off-road engine meeting the current model year standards in effect at the time the engine is added to the fleet. If the engine is pre-2004, then the highest level available verified diesel emission control system (VDEC) must be installed within one year. In-use yard tractors are required to meet either 2007 or later certified on-road engine standards, Final Tier 4 off-road engine standards, or install verified controls that will result in equivalent or fewer DPM and NOx emissions than a Final Tier 4 off-road engine. In-use non-yard tractors must either install the highest level available VDEC and/or replace to an on-road or off-road engine meeting the current model year standards. For all CHE, compliance dates are phased-in beginning December 31, 2007, based on the age of the engine and number of equipment in each model year group.

CAAP Measures- SPBP-CHE1- Performance Standards for CHE

This measure calls for further CHE improvements at the time of terminal lease renewal. Beginning in 2007, all CHE purchases must meet the following performance standards of the cleanest available NOx alternative-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase; or cleanest available NOx diesel-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase. If there are no engines available that meet 0.01 g/bhp-hr PM, then must purchase cleanest available engine (either fuel type) and install cleanest VDEC available.
In addition, by the end of 2010, all yard tractors operating at the San Pedro Bay Ports must meet at a minimum the EPA 2007 on-road or Tier 4 engine standards. By the end of 2012, all pre-2007 on-road or pre Tier 4 off-road top picks, forklifts, reach stackers, rubber tired gantry cranes (RTGs), and straddle carriers <750 hp must meet at a minimum the EPA 2007 on-road engine standards or Tier 4 off-road engine standards. By end of 2014, all CHE with engines >750 hp must meet at a minimum the EPA Tier 4 off-road engine standards. Starting 2007 (until equipment is replaced with Tier 4), all CHE with engines >750 hp will be equipped with the cleanest available VDEC verified by CARB.

1.4.4 Railroad Locomotives


In March 1998, EPA adopted Tier 0 (1973-2001), Tier 1 (2002-2004), and Tier 2 (2005+) emissions standards applicable to newly manufactured and remanufactured railroad locomotives and locomotive engines. These standards require compliance with progressively more stringent standards for emissions of hydrocarbon, CO, NOx, and DPM. Although the most stringent standard, Tier 2, results in over 40% reduction in NOx and 60% reduction in DPM compared to Tier 0, full potential of these reductions will not be realized in the next five years because of the long life of diesel locomotive engines.

In March 2008, EPA finalized the regulation – “Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters per Cylinder.” When fully implemented, this rule will cut PM emissions from these engines by as much as 90% and NOx emissions by as much as 80%.

The regulation introduces two tiers of standards – Tier 3 and Tier 4 – which apply to new locomotives as well as standards for remanufactured locomotives, as follows:

- **Newly-Manufactured Locomotives:** The new Tier 3 emission standards will achieve 50% reduction in PM beyond the current Tier 2 standards and will become effective in 2012. The longer term Tier 4 emission standards which are based on the application of high efficiency catalytic after-treatment technologies for NOx and PM will become effective in 2015 and will achieve over 80% reduction in PM and NOx compared with the current Tier 2 standards.

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Remanufactured Locomotives: The regulation also establishes emission standards for remanufactured Tier 0, 1, and 2 locomotives which would achieve approximately 50% reduction in PM and up to 20% reduction in NOx.

CARB’s Low Sulfur Fuel Requirement for Intrastate Locomotives

In 2004, CARB adopted a low sulfur fuel requirement for intrastate locomotives. Intrastate locomotives are defined as those locomotives that operate at least 90 percent of the time within the borders of the state, based on hours of operation, miles traveled, or fuel consumption. Mostly applicable to switchers, starting January 1, 2006 statewide, intrastate locomotives are required to use CARB off-road diesel fuel which has a sulfur content limit of 15 ppm and a lower aromatic content. The use of fuel with lower sulfur and aromatics will result in NOx and DPM reductions. In addition, use of low sulfur fuel will facilitate retrofitting locomotives with emissions control devices such as DPFs that have potential to reduce DPM by 85%.

Statewide 1998 and 2005 Memorandum of Understanding (MOU)

In order to accelerate the implementation of Tier 2 engines in the SoCAB, CARB and EPA Region 9 entered into an enforceable MOU in 1998 with two major Class 1 freight railroads [Union Pacific (UP) and Burlington Northern Santa Fe (BNSF)] in California. This MOU requires UP and BNSF to concentrate introduction of the Tier 2 locomotives in the SoCAB, which will achieve 65% reduction in NOx by 2010. In 2005, CARB entered into another MOU with UP and BNSF whereby the two railroads agreed to phase out non-essential idling and install idling reduction devices, identify and expeditiously repair locomotives that smoke excessively and maximize the use of 15 ppm sulfur fuel.

1.4.5 Heavy-Duty Vehicles

Emission Standards for New 2007+ On-road Heavy-Duty Vehicles

In 2001, CARB adopted EPA’s stringent emission standards for 2007+ On-road Heavy Duty Vehicles (HDV), which will ultimately result in 90% reductions in emissions of NOx and particulate matter (PM). This regulation will require HDV engine manufacturers to meet a 0.01 g/bhp-hr PM standard starting in 2007, which is 90% lower than the 2004 PM standard of 0.1 g/bhp-hr. The regulation requires a phase-in of a 0.2 g/bhp-hr NOx standard between 2007 and 2010. By 2010, all engines will be required to meet the 0.2 g/bhp-hr NOx standard, which represents a greater than 90% reduction compared to the 2004 NOx standard of 2.4 g/bhp-hr. It is expected that between 2007 and 2010, on average, manufacturers will produce HDV engines meeting a PM standard of 0.01 g/bhp-hr and a NOx standard of 1.2 g/bhp-hr. This latter is referred to as the 2007 interim standard.
**CARB's Heavy-Duty Vehicle On-Board Diagnostics (OBD) Requirement**

In 2005, CARB adopted a comprehensive HDV On-Board Diagnostics (OBD) regulation, which ensures that the increasingly stringent HDV emissions standards being phased in are maintained throughout the vehicle’s useful life. The OBD regulation requires manufacturers to install a system in HDVs to monitor virtually every emissions related component on the vehicle. The OBD regulation will be phased in beginning with the 2010 model years with full implementation required by 2016.

**CARB's Ultra-Low Sulfur Diesel (ULSD) Fuel Requirement**

In 2003, CARB adopted a regulation requiring that diesel fuel produced or offered for sale in California for use in any on-road or non-road vehicular diesel engine (with the exception of locomotive and marine diesel engines) contain no more than 15 ppm of sulfur by weight, beginning June of 2006, statewide. This ULSD fuel is needed in order for retrofit technologies, such as diesel particulate filters, to work successfully.

**CARB’s Regulation for Reducing Emissions from On-road Heavy-Duty Diesel Trucks Dedicated to Goods Movement at California Ports**

As a part of CARB’s emissions reduction plan for ports and goods movement in California, in December of 2007, CARB board adopted a regulation to modernize the drayage truck fleet that operate at California’s ports. This objective is to be achieved in two phases:

1. **By 31 December 2009,** all pre-1994 model year (MY) engines are to be retired or replaced with 1994 and newer MY engines. Furthermore, all drayage trucks with 1994 – 2003 MY engines will be required to achieve an 85 percent PM emission reduction through the use of an ARB approved Level 3 VDECS.

2. **By 31 December 2013,** all trucks operating at California ports must comply with the 2007+ on-road heavy-duty truck engine standards.

**CARB’s Truck and Bus Regulation**

In December 2008, CARB adopted a regulation that places requirements on in-use HDVs operating throughout the state. Under the regulation, existing HDVs are required to be replaced with HDVs meeting the latest NOx and PM BACT. By January 1, 2021, all MY 2007 trucks are required to meet NOx and PM BACT (i.e. 2010+ EPA Engine Standards). MY 2008 and MY 2009 must be replaced with 2010+ engines by January 1, 2022 and January 1, 2023 respectively.
CARB’s Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Regulation
In December 2008, CARB adopted a new regulation to reduce greenhouse gas emissions by improving the fuel efficiency of heavy-duty tractors that pull 53-foot or longer box-type trailers through improvements in tractor and trailer aerodynamics and the use of low rolling resistance tires. All pre-2011 MY tractors that pull affected trailers are required to use SmartWay verified low rolling resistance tires, beginning January 1, 2012. Pre-2011 MY 53-foot or longer-type box trailers are required to be SmartWay certified or retrofitted with SmartWay verified technologies by December 31, 2012 with the exception of 2003-2008 MY refrigerated-van trailers equipped with 2003 or later transport refrigeration units which will have a compliance phase-in between 2017 and 2019. Drayage tractors and trailers that operate within a 100 mile radius of a port or intermodal rail yard are exempt from this regulation.

CAAP Measures- SPBP-HDV1- Performance Standards for On-road Heavy-Duty Vehicles; Clean Trucks Program
Per the stated goals of the CAAP, the ports of Long Beach and Los Angeles approved the Clean Trucks Program (CTP) which progressively bans older trucks from operating at the two ports. The ban is implemented in three phases as follows:

1. By 1 October 2008 – All pre-1989 trucks are banned from port services.

2. By 1 January 2010 – All 1989-1993 trucks along with un-retrofitted\(^25\) 1994-2003 trucks are banned from port services.

3. By 1 January 2012 – All trucks that do not meet 2007 and later on-road heavy-duty engine standards are banned from port services.

1.4.6 Greenhouse Gases
Assembly Bill 32 (AB32), the California Global Warming Solutions Act of 2006, establishes a first-in-the world comprehensive program requiring CARB to develop regulatory and market mechanisms that will ultimately reduce green house gas (GHG) emissions to 1990 levels by the year 2020 and further reduce GHG emissions to 80 percent below 1990 levels by 2050. Mandatory caps will begin in 2012 for significant sources and ratchet down to meet the 2020 goals.

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\(^{25}\) CTP retrofit requirements include ARB Level 3 reduction for PM plus 25% NOx reduction.
On October 25, 2007, CARB approved several emission reduction strategies to reduce GHG emissions as “early action measures.” Early action measures pertaining to goods movement activities for ships, port drayage trucks, cargo handling equipment and transport refrigeration units included:

- Green Ports (Ship Electrification)
- SmartWay Truck Efficiency
- Tire Inflation Program
- Anti-idling Enforcement
- Refrigerant Tracking, Reporting, and Recovery Program
- Low Carbon Fuel Standard

In December 2007, CARB approved the 2020 statewide GHG emission limit of 427 million metric tons of carbon dioxide equivalent (MMT CO₂E). Also in December 2007, CARB adopted a regulation requiring the largest industrial sources to report and verify their greenhouse gas emissions. In December 2008, CARB adopted the Climate Change Scoping Plan to achieve the reductions in greenhouse gas (GHG) emissions mandated in AB32. The AB32 Scoping Plan contains the main strategies California will use to reduce the GHGs that cause climate change. Several of these measures are targeted at goods movement, including ports and are expected to achieve a combined 3.7 million metric tons of carbon dioxide equivalent. Proposed measures in the Scoping Plan include:

- T-5: Ship electrification at ports (previously adopted as regulation in December 2007)
- T-6: Goods movement efficiency measures (Port Drayage Trucks regulation adopted in December 2007; other measures under development)
- T-7: Heavy-Duty Vehicle GHG Emission Reduction (adopted December 2008)

In addition, the following Scoping Plan’s specific measures are planned for adoption in the next few years with potential impacts on Port-related sources:\(^{26}\)

- Transport Refrigeration Units Cold Storage Prohibition and Energy Efficiency
- Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers
- Medium and Heavy-Duty Vehicle Hybridization
- Cargo Handling Equipment – Anti-Idling, Hybrid, Electrification
- Commercial Harbor Craft Maintenance and Design efficiency
- Goods Movement System-Wide Efficiency Improvements

\(^{26}\) [http://www.arb.ca.gov/cc/scopingplan/sp_measures_implementation_timeline.pdf](http://www.arb.ca.gov/cc/scopingplan/sp_measures_implementation_timeline.pdf)
The recently adopted CARB regulations, the anticipated CARB rulemakings, and the measures in the CAAP will provide a vital and complementary combination of measures that support the overall effort to meet both the State and San Pedro Bay Ports air quality improvement goals.

1.4.7 Non-Regulatory Programs
Non-regulatory grant funding programs are also helping to significantly reduce emissions from sources including those associated with ports. In 2009, the port submitted several grant applications to EPA, California Energy Commission (CEC) and Department of Energy (DOE) for American Recovery and Reinvestment Act (ARRA) funding. In 2009, the port received $4 million in funding to replace, repower, and/or retrofit 112 pieces of equipment, including harbor craft, currently in operation at the port. The emission reductions achieved will improve air quality and health in the surrounding area.

Another example of these types of programs is the Carl Moyer Program. This program is a CARB-administered grant program implemented in partnership with local air districts to fund the replacement of older, higher emitting engines or to cover the incremental cost of purchasing cleaner-than-required engines and vehicles. Under this program, owners/operators of mobile emissions sources can apply for incremental funding to reduce emissions. The program also includes a fleet modernization component. It is important to note that only emission reductions that are surplus to regulatory requirements are eligible for Carl Moyer funding. As regulations are developed which require retrofit or replacement of specific equipment and/or vehicles, those projects will no longer be eligible for funding. In addition to the Carl Moyer Program, Proposition 1B (the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006), passed by voters in November 2006, has authorized $1 billion in bond funding over 4 years for incentives to reduce diesel emissions associated with goods movement. Under this Program, CARB will work in partnership with local public agencies (i.e., air quality management districts and ports) to identify and fund qualified projects. Local agencies would request funding from the CARB to provide financial incentives to owners of equipment used in goods movement in order to upgrade to cleaner technologies. In August of 2008, the ports received $98 million from this program which is leveraged by $145 million from the ports to help truckers who frequently service the ports to modernize their existing trucks.
1.5 Scope of Study

The scope of the study is described in terms of the year of activity used as the basis of emissions estimates, the pollutants quantified, the included and excluded source categories and the geographical extent. The purpose of the 2009 Inventory of Air Emissions (2009 EI) is to develop emission estimates based on activities that occurred in calendar year 2009.

1.5.1 Pollutants

Exhaust emissions of the following pollutants have been estimated:

- Particulate matter (PM) (10-micron, 2.5-micron)
- Diesel particulate matter (DPM)
- Oxides of nitrogen (NOx)
- Oxides of sulfur (SOx)
- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)

Most port-related sources of GHG involve fuel combustion, thus CO2, CH4 and N2O are included in the list of pollutants for this inventory. The other GHG, such as fluorinated gases (i.e. high-global warming potential gases) are not included since they are mainly caused by industrial processes not typically found at ports or in the maritime industry.

The greenhouse gases, CO2, CH4 and N2O have been estimated based on emission factors presented in the corresponding source category sections and/or appendices. Each greenhouse gas differs in its ability to absorb heat in the atmosphere. Estimates of greenhouse gas emissions are also presented in units of carbon equivalents, which weighs each gas by its global warming potential (GWP) value. To normalize these values into a single greenhouse gas value, the GHG emissions estimates are multiplied by the following values and then added together resulting in a single greenhouse gas value (CO2 equivalent). The values are as follows27:

- CO2 – 1
- CH4 – 21
- N2O – 310

1.5.2 Emission Sources
The scope includes the following five source categories:

- Ocean-going vessels
- Harbor craft
- Cargo handling equipment
- Railroad locomotives
- Heavy-duty vehicles

Examples of the five sources include the containerships, tankers, and cruise ships that call on the Port; the assist tugs and tugboats that assist vessels in the harbor; the cranes and forklifts that may move cargo within the terminals; the railroad locomotives that haul cargo; and the on-road diesel trucks visiting the terminals that also transport cargo. The inventory does not include stationary sources, as these are included in stationary source permitting programs administered by the SCAQMD. The inventory does not include emissions from vessels and equipment used for oil production operations located within the port boundary and offshore. The oil industry-related emissions were included in a separate study conducted by the Port.

1.5.3 Geographical Extent
The 2009 emissions inventory (EI) includes tenant source category emissions from Port-related goods movement activities that occur on Port-owned and privately-owned land within the Port of Long Beach Harbor District. An overview of the geographical extent is provided below for each of the source categories.

For marine vessels, OGVs and commercial harbor craft, the geographical extent of the EI is based on the same boundary that was used in previous marine vessel inventories developed for the SCAQMD. The portion of the study area outside the Port’s breakwater is four-sided, and geographically defined by the following coordinates:

- NW corner: 34°02'42.4” north (N) latitude by 118°56'41.2” west (W) longitude
- SW corner: 33°00'00.0” N latitude by 119°30'00.0” W longitude
- SE corner: 32°30'00.0” N latitude by 118°30'00.0” W longitude
- NE corner: 33°23'12.7” N latitude by 117°35'46.4” W longitude
Figure 1.5 shows the geographical extent of the study area for marine vessels in dark blue.

**Figure 1.5: OGV and Harbor Vessel Out of Port Geographical Extent**
The geographical scope for cargo handling equipment is the terminals and facilities on which they operate. Figure 1.6 shows the land area of active Port terminals in 2009.

**Figure 1.6: Port of Long Beach Map of Terminals**

Emissions from switching and line haul railroad locomotives were estimated for on-dock rail yards, intermodal yards on Port property, and the rail lines linking these facilities. For heavy-duty trucks related to the hauling of cargo, emissions from queuing at terminal entry gates, for travel and idling within the terminals, and for queuing at the terminal exit gates have been included. In addition to emissions that occur inside the Port facilities, emissions from locomotives and on-road trucks transporting cargo to or from the Port have been estimated for activity that occurs within the SoCAB boundaries. Emissions are estimated up to the cargo’s first point of rest within the SoCAB or up to the basin boundary, whichever comes first. First point of rest is the location where the cargo, such as a container of goods, is first off-loaded from the transport device (truck or train) after leaving the Port. Examples include cargo transported from the Port by truck to a distribution center or to an off-Port intermodal yard.
Figure 1.7 shows the SoCAB boundary for rail and HDV in relation to the location of the Port. Since the ports of Long Beach and Los Angeles are interconnected with intermodal transportation linkages, every effort was made to only account for freight movements originating from or having a destination at the POLB.

**Figure 1.7: South Coast Air Basin Boundary**

1.5.4 Facilities Not Included
There are certain industrial operations and other emission-producing activities that are located on Port property or on private property within the Port boundaries that are not included in this inventory. The facilities that have not been included are:

- Harbor Cogeneration
- South East Resource Recovery Facility
- Tidelands Oil Production Company
- THUMS Oil Operations
- Long Beach Generation
Some of these operations and activities are within the Port for historical reasons, for example some operations were present prior to an area becoming Port property. Other operations take place on property leased from Port but are not in any way related to the activities or operations of the Port, and in many cases, the Port does not have authority or influence over these operations.

Emissions associated with the oil operations located at the Port are excluded from this inventory (Tidelands and Thums Oil Operations) but are included in a separate study conducted to quantify oil industry-related emissions published in 2006 [28]. Stationary sources are not included in this inventory.

1.6 General Methodology

The basic approach to developing an activity-based EI is through data collection efforts with Port tenants, who own, operate and maintain equipment and own or charter vessels. Port tenants and shipping lines play an essential role in the development of an EI by providing the most accurate activity and operational information available. The activity and operational data collected is input into a database for storage. Emissions estimates are developed for each of the various source categories in a manner consistent with the latest estimating methodologies agreed upon by the Port and the participating regulatory agencies. The information gathered, analyzed, and presented in this EI continues to improve the understanding of the nature and magnitude of Port-related emission sources. Specific data collection and analytical approaches unique to each of the five source categories are summarized below along with a summary of the key updates.

In general, emissions estimates are calculated by multiplying units of activity (estimated using the activity and operational information described above) by an emission factor. Emission factors are standard values that express the mass of emissions in terms of a unit of activity. For example, some emission factors are expressed in terms of pounds of emissions (of a particular pollutant) per horsepower-hour. Horsepower-hours are the product of in-use horsepower times hours of operation. Emissions estimates can be calculated, then, by multiplying hours of operation per year (activity data) by in-use horsepower (operational information) by an emission factor (such as pounds per horsepower-hour) to provide a result of emissions in pounds of emissions per year. The actual calculations are often more complex than this example, because such parameters as in-use horsepower must be estimated as part of the calculations. In addition, the emission factors often vary depending on equipment-specific factors such as the model year and the accumulated hours of use, and fuel correction factors may need to be applied.

1.6.1 Ocean-Going Vessels

The basic methodology for estimating emissions from the various types of ocean-going vessels that call on the Port relies on local activity-based data to the greatest extent possible. This includes call records from the Marine Exchange of Southern California, which tracks and records the movement of all OGVs entering or departing San Pedro Bay and information from the Jacobsen Pilots. In addition, the Port has undertaken a Vessel Boarding Program (VBP) that focuses on gathering specific vessel characteristics and operational data from ships visiting the Port, to gain a greater understanding of how the different types of OGVs arrive, depart, and transit San Pedro Bay and the harbor, as well as how they operate while at dock ("hotelling").

Additional ship-specific OGV data was obtained from Lloyd's Register of Ships (Lloyd’s), a marine vessel data system that can provide vessel specific data for virtually every OGV in the world fleet. Lloyd’s data was also used to develop profiles for parameters that are not known for every ship. The general vessel classifications include the following.

- Automobile carriers
- Bulk carriers
- Containerships
- Cruise ships
- General cargo ships
- Ocean-going tugboats
- Refrigerated vessels
- Roll-on roll-off ships
- Tankers

Emission factors were developed for different types of OGV engines based on review of the literature and discussion/coordination with the regulatory agencies. Emissions were calculated by multiplying the emission factors by vessel-specific activity parameters such as in-use horsepower and hours of operation. Numerous calculations were made for each port visit to adequately characterize the complicated activities of OGVs; (e.g., separate calculations were made for vessel transit, maneuvering, and hotelling activities for propulsion, auxiliary engines, and auxiliary boilers). The results of all the calculations were summed to produce the overall emission estimates.
The emission estimates presented in the 2009 EI include the effects of the following emission reduction measures in place in 2009.

- The Port’s Green Flag Program, requiring reduced speeds of 12 knots or lower during transiting outside the harbor and within 20 nautical miles (nm) of the Port, was expanded to 40 nm starting in January 2009.
- The use of shore power at various facilities including a container terminal, liquid bulk terminal, and ready-reserve vessels berth.
- Vessels switching to a lower sulfur fuel near the coast and at berth pursuant to CARB’s Marine Fuel Regulation and Port’s Vessel Fuel Incentive Program.
- Newer vessels calling at the Port with cleaner and more fuel-efficient engines that meet or exceed standards set by the IMO.
- New technologies added to vessels that reduce emissions such as fuel slide valves.

### 1.6.2 Harbor Craft

Harbor craft operators whose vessels work within Port waters were interviewed to update the inventory of harbor craft. The harbor craft are separated into the following categories:

- Assist tugboat
- Tugboats
- Ferries
- Excursion vessels
- Crew boats
- Work boats
- Government vessels

The emission estimation methodology for this category is consistent with CARB’s latest methodology. Emissions were calculated by multiplying the emission factors by the appropriate measure of activity (i.e., annual hours of operation) on an engine by engine basis for each vessel included in the inventory. Updated activity information for vessels’ operating hours, and the size and model year of propulsion and auxiliary engines was obtained from harbor craft operators.

The 2009 emission estimates for harbor craft reflect the emission benefits associated with replacement of older higher emitting engines with cleaner engines as well as the operation of newer vessels with cleaner engines. The first hybrid tugboat was in operation for the first time in 2009 and is included in the 2009 emission estimates for harbor craft.
1.6.3 Cargo Handling Equipment
Cargo Handling Equipment (CHE) consists of various types of equipment and vehicles that fall within the off-road designation and are used to move cargo within terminals and other off-road areas. The emission estimation methodology for this category is consistent with CARB’s latest CHE emissions estimation methodology. Equipment operators and owners were asked to supply updated information such as activity hours, size and model year of all of their CHE used at the Port.

The 2009 emission estimates for cargo handling equipment reflect the emission benefits associated with the implementation of the CAAP measure and CARB’s regulation which have resulted in the purchase of cleaner equipment and retrofit of existing equipment with emission control technologies.

1.6.4 Railroad Locomotives
Railroad operations are typically described in terms of two different types of operation, line haul and switching. Line haul operations involve long-distance transportation between the Port and points across the country whereas switching is the local movement of railcars to prepare them for line haul transportation or to distribute them to destination terminals upon their arrival in port. Different companies conduct switching (Pacific Harbor Line [PHL]) and line haul (Burlington Northern Santa Fe [BNSF] and Union Pacific [UP]) operations within the Port. The line haul companies also operate switching locomotives at off-port rail yards.

The on-port switching company operates a dedicated fleet of locomotives, while the line haul locomotives that service the Port are part of a nation-wide fleet, meaning that individual locomotives are not assigned specifically to port or South Coast Air Basin service. Therefore, the types of information available for these two types of activity differs for the on-port switching locomotives, information on each locomotive and its activity (e.g., fuel use and throttle notch setting frequency) can be used to estimate emissions; whereas for the line haul locomotives the information is more general (e.g., in terms of fuel use per ton of cargo and total tons of cargo carried).

The 2009 emission estimates for locomotives reflect the emissions benefits associated with the operation of cleaner locomotives and the implementation of memorandum of understanding (MOUs) between Class 1 Railroads, CARB and the U.S. Environmental Protection Agency (EPA).
1.6.5 Heavy-Duty Vehicles

Heavy-duty on-road vehicles transport cargo between the port and off-port locations such as rail yards, warehouses, and distribution centers. To develop emission estimates, truck activities have been evaluated as having two components:

- On-terminal operations, which include waiting for terminal entry, transiting the terminal to drop off and/or pick up cargo, and departing the terminals.

- On-road operations outside the Port boundaries but within the SoCAB. This includes travel within the boundaries of the adjacent Port of Los Angeles, because the routes many trucks take run through both ports on the way to and from Port terminals.

For estimating on-road HDV emissions, activity information was developed by a traffic consultant using the trip generation and travel demand models. For estimating on-terminal HDV emissions, terminal operators were interviewed with regards to on-terminal traffic patterns, including time spent waiting at the entry gate, time and distance on terminal while dropping off and/or picking up cargo, and time spent waiting at exit gates.

Emissions from HDVs were estimated by multiplying the speed-specific emission factor derived from ARB’s emission factor model EMFAC 2007 by the distance parameters established for the terminals (on-terminal emissions) or road segments (on-road emissions). On-terminal idling emissions were estimated by multiplying the EMFAC idling emission factor by estimated idling times.

The emissions benefits associated with the implementation of the Port’s Clean Truck Program in 2009 are reflected in the 2009 emissions estimates for heavy-duty trucks.
1.7 Report Organization

This report presents the emissions and the methodologies used for each category in each of the following sections:

- Section 2 discusses ocean-going vessels
- Section 3 discusses harbor craft
- Section 4 discusses cargo handling equipment
- Section 5 discusses locomotives
- Section 6 discusses heavy-duty vehicles
- Section 7 discusses findings and results
- Section 8 compares 2009 emissions to 2005 emissions
- Section 9 discusses emissions metrics by source category
- Section 10 discusses anticipated impacts of control programs on emissions and improvements to methodologies for estimating emissions

The report also includes:

- Appendix A – Ocean-going vessels
- Appendix B – Harbor craft
- Appendix C – Cargo handling equipment
- Appendix D – Heavy-duty vehicles